



BTEC Assignment Brief

Qualification	Pearson BTEC International Level 3 Foundation Diploma in Applied Science Pearson BTEC International Level 3 Diploma in Applied Science Pearson BTEC International Level 3 Diploma in Biomedical Science Pearson BTEC International Level 3 Diploma in Environmental Science Pearson BTEC International Level 3 Extended Diploma in Applied Science Pearson BTEC International Level 3 Extended Diploma in Biomedical Science Pearson BTEC International Level 3 Extended Diploma in Environmental Science
Unit number and title	Unit 16: Applications of Inorganic Chemistry
Learning aim(s)	B: Investigate the solubility and chemical energetics of ions to understand the properties of inorganic compounds
Assignment title	Solubility and chemical energetics of ions
Assessor	
Issue date	
Hand in deadline	

Vocational Scenario or Context	You are a laboratory technician working for a chemical company that specializes in making inorganic compounds. In your role you need to have practical experience and an understanding of the solubility and the chemical energetics of ions. It is important for you to have knowledge of the energy change that takes place when different inorganic compounds dissolve in solvents such as water and the energy change that takes place during neutralisation. It is also important for you to have knowledge of how soluble different inorganic compounds are in solvents at different temperatures and when different solutions become saturated. Your supervisor has set up some Continuing Professional Development (CPD) for you to ensure that your knowledge and skills remain up to date.
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Task	As part of your annual CPD in your role of laboratory technician you are required to investigate enthalpy changes of neutralisation and solution and determine two solubility curves. Your supervisor has also asked you to prepare a report that assesses the effect of ionic charge and radius upon hydration enthalpy, lattice energy and solubility and predicts the solubility of inorganic compounds. You must also perform calculations of enthalpy changes involving ions. Your final portfolio must contain the following five sections: Section 1 - Enthalpy Changes Calculations Test Your Supervisor will provide you with the 'Enthalpy Changes Calculations Test' to enable you to perform calculations from at least ten questions involving standard enthalpy changes associated with ionic compounds
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such as lattice energy, hydration enthalpy and standard enthalpy of solution.

Section 2 – Investigation to **determine** the solubility curves for two inorganic compounds in water

- You will collect data for the solubility of two inorganic compounds in water at different temperatures to plot solubility curves (e.g. potassium nitrate and sodium chloride). At least five measurements of solubility for each compound are required to plot the solubility curves. You must draw conclusions and comparisons about the solubility of the two compounds.

Section 3 - Investigation to determine enthalpy changes when acids neutralise alkalis and when ionic compounds dissolve in water

- You must **investigate** four inorganic acids/alkali reactions (e.g. hydrochloric acid, sulfuric acid, sodium hydroxide, ammonium hydroxide) and four ionic compounds dissolving in water (e.g. sodium chloride, ammonium chloride, potassium chloride, sodium carbonate, calcium chloride, sodium hydrogencarbonate). Calculate the enthalpy change per mole for each reaction (8 in total). Make comparisons and draw conclusions about the enthalpy changes you have determined..

Section 4 - The '**Predict** the Solubility of Inorganic Compounds Calculations Test'

- Your Supervisor will provide you with the '**Predict** the Solubility of Inorganic Compounds Calculations Test' to enable you to carry out a range of calculations to determine the ionic product of a compound when two solutions are mixed. You will be required to compare this value against the solubility product K_{sp} to determine whether the compound formed remains in solution or will precipitate. Your calculations will involve compounds of the formulae XY, X_2Y and XY_2 , involving ions with charges +1, +2, -1 or -2.

Section 5 – The theory of hydration enthalpy

- **Assess** how the charge and radius size of ions affects the magnitude of hydration enthalpy when interacting with water molecules, the magnitude of the lattice energy when combined with other ions and how the balance between the two enthalpy terms affects solubility (eg trends in group 2 hydroxides and sulfates). Consider the polarising power of cations and polarisability of anions to explain why some ionic lattices are more energetically stable than expected (e.g. silver halides) and why some decompose more readily than others (e.g. the trend in Group 2 carbonates).



Checklist of evidence required	A detailed report containing results and calculations that includes: • An investigation to determine of solubility curves • An investigation of enthalpy changes of neutralization and solution • Calculations of enthalpy changes involving ions (Enthalpy Changes Calculations Test) • A prediction of the solubility of inorganic compounds ('Predict the Solubility of Inorganic Compounds Calculations Test') • An assessment of the effect of ionic charge and radius
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Criteria covered by this task:	
Unit/Criteria reference	To achieve the criteria, you must show that you are able to:
B.D2	Assess the effect of ionic charge and radius upon hydration enthalpy, lattice energy and solubility
B.M4	Predict the solubility of inorganic compounds by comparison of calculated ion product values against literature values for the solubility product K_{sp}
B.M3	Perform calculations of enthalpy changes involving ions using enthalpy cycles
B.P4	Investigate enthalpy changes of neutralisation and solution for inorganic compounds
B.P3	Determine solubility curves for inorganic compounds
Sources of information to support you with this Assignment	All sources of information suggested are UK based. Centres are free to amend these sources to those available in the Country of delivery where more appropriate. www.STEM.org.uk – solubility, chemical energetics, Born-Haber cycles www.edu.rsc.org - The effect of temperature on solubility Nuffield practical collection Energy changes in neutralisation Within the copyright laws learners could search YouTube for – What is K_{sp}; Solubility Product Constant; Enthalpy Change of Solution and Hydration - A level chemistry Solubility Curves; Born Haber Cycle
Other assessment materials attached to this Assignment	The Centre will be required to provide learners with two additional documents that the Centre will design. These documents should be internally verified as part of this assignment brief. These are: 1. The 'Enthalpy Changes Calculations Test' which, should have at least ten questions involving the calculation of standard enthalpy changes



Brief	associated with ionic compounds such as lattice energy, hydration enthalpy and standard enthalpy of solution. For lattice energy, this will involve the construction and use of Born-Haber cycles to determine a value from standard enthalpies of formation, atomisation, ionisation energy and electron affinity (or one of these values given the lattice energy). For enthalpies of solution or hydration, this will involve the construction of an energy cycle and the use of the equation $\Delta H_{\text{soln}} = -\Delta H_{\text{lat}} + \Delta H_{\text{hyd}}$. Questions will involve ionic compounds of the formulae XY, X₂Y, and XY₂ involving ions with charges of +1, +2, -1 or -2. 2. The 'Predict the Solubility of Inorganic Compounds Calculations Test' which, should have at least 10 questions to determine the ionic product of a compound when two solutions are mixed. Learners must be tasked with comparing this value against the solubility product value (K_{sp}) to determine whether the compound formed remains in solution or will precipitate. Calculations must involve the formation of ionic compounds of the formulae XY, X₂Y, and XY₂ involving ions with charges of +1, +2, -1 or -2 (e.g. AgCl, BaSO₄, Ag₂S, Mg(OH)₂, PbBr₂). Learners must also be required to calculate the maximum concentration of two solutions that can mixed before K_{sp} is exceeded and precipitation will occur.
Notes to the Assessor and technician	The practical activities suggested for this assignment are required to be safety checked by the Centre before use. Pearson Education can take no responsibility for the safety of any practical activities. Before doing any practical activity, you should always carry out your own risk assessment and refer to the necessary regulations. In particular, any local rules issued by your employer must be obeyed, regardless of what is suggested here. Centre should use Health and Safety information provided by a reputable source. In the UK such an example organization is CLEAPSS http://science.cleapss.org.uk/